## REMARKS

Claim 27 stands rejected under 35 USC §103(a) as allegedly unpatentable over Japanese Patent Publication 6-287640 ("Japan '640") in view of ASM Metals Handbook or Japanese Patent No. 2000-054301 ("Japan '301"). The reasons for the rejection are set forth on pages 3-4 of the Official Action. The rejection is moot in view of the cancellation of Claim 27.

Claims 28-34 stand rejected under 35 USC §103(a) as allegedly unpatentable over Japan '640 in view of ASM Metals Handbook or Japan '031 and further in view of U.S. Patent No. 4,113,166 ("Ollson"), U.S. Patent No. 3,512,574 ("Taylor") or Japanese Patent Publication No. 2-672889 ("Japan '889"). The reasons for the rejection are set forth on page 4 of the Official Action. This rejection is respectfully traversed.

Claim 28 has been rewritten in independent form and sets forth a method of manufacturing an ultra-low carbon steel sheet in which molten steel having a chemical composition including, in mass percent, C: at most 0.010%, Si: at most 0.5%, Mn: at most 1.5%, P: at most 0.12%, S: at most 0.030%, Al: at most 0.080%, N: at most 0.0080%, Ti: 0.002% ~ 0.10%, Nb: at most 0.05%, B: 0-0.0050%, V: 0-0.05%, and Ca: 0-0.0050% is subjected to refining in a converter, secondary refining after refining in the converter, continuous casting, hot rolling, and then coiling, wherein at the time of the secondary refining, the molten steel is tapped into a refining vessel, a vacuum immersion pipe having an interior that can be adjusted to a negative pressure is immersed in the molten steel in the refining vessel, and a stirring gas is blown into the molten steel, wherein the amount of

FeO+MnO in a slag in the refining vessel is at most 15 mass %, and the throughput at the time of casting is at most 5 tons per minute.

The combinations of features recited in Claim 28 and in Claim 32 dependent thereon are not disclosed or suggested by the applied combination of references. The subject matter of Claim 28 relates to a process for producing an ultra-low carbon steel with a reduced amount of inclusions. Unobviousness of the claimed method is established by the data set forth Tables 2-3 and in Figures 1 and 2 of the present application. As explained in the specification, when the amount of inclusions in terms of FeO+MnO in the slag exceeds 15 mass % there is an abrupt increase in the amount of cluster-type inclusions (see page 10, lines 2-6 and Figure 1) and the amount of spheroidal inclusions abruptly increases when throughput exceeds 5 tons per minute (see page 10, lines 14-25 and Figure 2). The data in the specification establishes that the claimed processing steps provide unexpected improvement in reducing inclusions which are detrimental to forming defects such as pin holes and press cracks (see page 1. lines 5-13; page 3, lines 11-24; and page 4, lines 6-25). As explained therein, ultra-low carbon steel undergoes mild deoxidation or does not undergo any deoxidation treatment at the time of tapping with the result that a large amount of oxide inclusions remain in the steel (page 4, lines 6-13). Applicants discovered an unobvious solution to this problem as set forth in the process steps recited in Claim 28.

Claim 28 recites a method of manufacturing an ultra-low carbon steel sheet in wherein the amount of FeO+MnO in a slag in the refining vessel is at most 15 mass % and the throughput at the time of casting is at most 5 tons per minute, features providing the unexpected results discussed above. Moreover, Claim 28 recites a

steel composition in which Ti is included in an amount of 0.002 to 0.10%, Japan '640 does not list Ti as an alloying element nor is there any example in Japan '640 of a Ti-containing steel. As explained below, Japan '640 adds Al so that oxides of Si and Mn are changed to Al oxide so as not to impede grain growth during magnetic annealing. Because substitution of Ti for Al would go against the teachings of Japan '640, it is submitted that it would not have been obvious to a person of ordinary skill in the art to use Ti to deoxidize the steel of Japan '640.

In the Official Action, Japan '031 is cited for disclosure of adding Ti to react with C, N and S to improve workability (Official Action at page 4) and the ASM Metals Handbook is cited for disclosure of adding Ti to steels as a deoxidizer and to limit grain growth (Official Action at bottom of page 3). The Official Action alleges that it would have been obvious to modify Japan '640 to include Ti to deoxidize and limit grain growth (sentence bridging pages 3-4 of the Official Action). Such a modification of Japan '640 would defeat the purpose of using Al to deoxidize the steel. In particular, at paragraph [0008] of Japan '640, Applicants advise that the following is stated:

> "After refining in a converter, the resulting molten steel is subjected to degassing under a vacuum to effect decarburization. After the decarburization, deoxidation is carried out by adding Al. Then, ferrous alloys containing Si, Mn, and the like are added so as to adjust a final alloy composition so that oxides in the form of $SiO_2$ and MnO are changed to $Al_2O_3$. This is because in the presence of oxides in the form of $Al_2O_3$, the grain growth can be promoted during final magnetic annealing. The present invention employs such a process so as to improve core loss."

In view of the explicit teachings of Japan '640, Al is required to deoxidize the steel and convert oxides of Si and Mn to $Al_2O_3$ which promotes grain growth during final magnetic annealing. Accordingly, it is submitted that persons of ordinary skill in the art at the time of the present invention would not have considered it obvious to

use of Ti in place of Al since such substitution would not achieve the objective of Japan '640 of converting MnO and $SiO_2$ to $Al_2O_3$.

In the Advisory Action, it is stated that:

> "Applicants argue that adding enough Ti to deoxidize the steel would have a deleterious effect on grain size and therefore magnetic properties, however this argument does not take the place of evidence. Nor does the examiner find sufficient evidence provided by the cited document." (Advisory Action, at page 2, paragraph 1a).
>
> "Applicant's arguments that by adding a sufficient amount of Ti to react with C, N and S to improve workability would be deleterious to grain size and/or magnetic properties are not evidence. Lacking evidence, examiner does not agree that it would necessarily be so." (Advisory Action, at page 2, paragraph 1b).

The evidence requested by the Examiner is submitted herewith. As shown in the attached partial machine translations of Japan Kokai 2001-73098 at paragraph [0026] and Japan Kokai 2004-169141 at paragraph [0017], Ti has adverse effects of grain growth of nonoriented silicon steel. In particular, these publications state the following:

> "The reason for controlling the total content of S, N, and Ti among unescapable impurities, so that 0.006 mass % (60 ppm) may not be exceeded is for reducing the concentration of the unescapable impurity (S, N, and Ti) which deposit in the grain boundary, bar recrystallization, and the grain growth possibility of a product is made to deteriorate, and has a bad influence on iron loss and a degree of hardness below on predetermined level, as mentioned above. The range of the desirable above mentioned concentration is below 0.004% (40 ppm)." Japan Kokai 2001-73098 [0026].
>
> "When Ti is made into 0.0030% or less and one sort of REM, Mg, and calcium or two sorts or more are contained 0.0005% or more with each content in addition to this, the reason for the ability to acquire good magnetic properties is considered as follows.
> By this invention method, after hot rolling, although it recrystallizes and normal grain growth of the steel plate is carried out between no pouring water, Ti generates detailed inclusion, such as TiN. If it exceeds 0.0030% and inclusion, such as detailed TiN, exists Ti mostly, recrystallization and normal grain growth will be controlled, and the diameter of crystal grain of the hot-rolling plate after rolling up will become small. Furthermore, recrystallization

> and normal grain growth are controlled also in continuous annealing after cold-rolling, and it is thought that magnetic properties deteriorate." Japan Kokai 2004-169141 [0017].

From the forgoing excerpts, it can be seen that Ti has adverse effects on desired grain growth of nonoriented silicon steels. Accordingly, the attached documents are evidence that persons of ordinary skill in the art would not have used Ti to deoxidize the steel of Japan '640 due to Ti's adverse effects on grain growth. As explained above, Japan '640 seeks to convert SiO and MnO to $Al_2O_3$ specifically because $Al_2O_3$ is not detrimental to grain growth. To use Ti in place of Al clearly would go against the teachings of Japan '640 and therefore is an unobvious modification of Japan '640.

Olsson, Taylor and Japan '889 are cited in the Official Action for the reasons cited in paragraphs 6-10 and 16 of the October 24, 2005 Official Action (Official Action at page 4). In paragraph 10 of the October 24, 2005 Official Action, these references are cited only for disclosure of casting at less than 5 tons per minute. No prior art is cited regarding the claimed feature of maintaining FeO + MnO in the slag at no more than 15 mass %. Given that the data in the specification establishes "abrupt" changes in amount of inclusions when FeO+MnO exceeds the claimed range and the prior art fails to recognize the effect of controlling the FeO+MnO content in the slag, it is submitted that the process recited in Claim 28 is clearly patentable over the combination of applied references.

It is submitted that the differences between the claimed subject matter and the prior art are such that the claimed subject matter, as a whole, would not have been obvious at the time the invention was made to a person having ordinary skill in the art.

In view of the foregoing, it is submitted that the present application is in condition for allowance and such action is earnestly solicited.

Respectfully submitted,

BUCHANAN INGERSOLL & ROONEY PC

Date: September 8, 2006

By: _____
Peter K. Skiff
Registration No. 31,917

P.O. Box 1404
Alexandria, Virginia 22313-1404
(703) 836-6620